

AEROBIOCONTAMINATION EMITTED BY A PERSON PLACED
IN A LAMINAR FLUX CHAMBER

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The recent introduction of the laminar flux technique in hospitals, especially in operating rooms, according to Coriell, Blakemore and McGarrity, poses the problem of aerobiocontamination emitted by the surgical team placed in the vicinity of the operating area.

The laminar flux technique, as one of us has indicated, makes it possible to reduce by a ratio of at least 100 the number of microorganisms in an enclosure. However, we wonder whether it is justified in operating areas, according to W. F. and M. W. Wells, because of the risk of polluting caused by the presence of the surgical team and the assistants. In order to avoid this condition, Charnley suggests the use of diving suits for the surgical team in which the air inside the diving suit is at a lower pressure compared with the outside air.

In the present note we propose to study the influence of one person and the head of one person on the degree of aerobiocontamination of an enclosure with a small degree of aerbiocontamination.

* Numbers in margin indicate pagination in original foreign text.

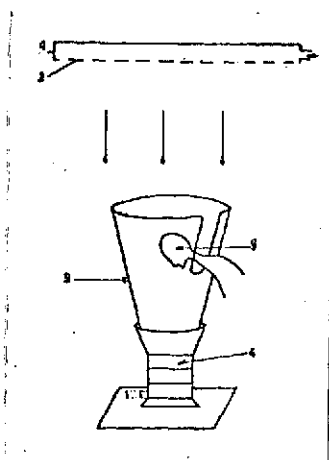


Figure 1. Diagram of the installation for studying the aerobiocontamination emitted by the head of a person located in an enclosure which is aerobiologically clean.

1- blower ceiling of the hood; 2- filters; 3- shield cone; 4- biocollector; 5- head.

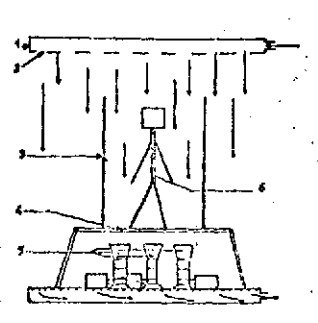


Figure 2. Diagram of the installation for studying the aerobiocontamination emitted by a person located in an enclosure which is aerobiologically clean.

1- blower ceiling of the hood; 2- filters; 3- bin; 4- floor with grid; 5- biocollectors; 6- person

The aerobiocontamination induced by the head of the person is obtained by placing it in a 2 m x 2 m cross section at a height of three meters having unidirectional vertical flow with a small degree of aerobiocontamination (on the order of 10 pne/m^3). An adjustable shield cone, which is directly adaptable to a Joubert type biocollector with an inlet diameter of 20 cm, is used to collect all the living microorganisms emitted with a flow rate of 750 l/min (Figure 1).

The number of particles causing a colony and the time of measurement makes it possible to determine the emission of the head in particles per minute (Figure 1).

The person is placed in the enclosure. The particles originate a colony which are emitted and are then collected downstream of the person using three Joubert type biocollectors. In order to capture all the microorganisms emitted by the human, he is placed in a parallelepiped box having the dimensions 0.60 x 0.60 x 2 M (Figure 2).

The isokinetic measuring of the air in a given volume during a given time can be used to calculate the degree of aerobio-contamination expressed in particles which form a basis of a colony per m^3 and the number of microorganisms emitted per person per minute.

Two different persons under different conditions carried out the manipulations for the emission of microorganisms by the head (with or without masks, with or without cap, speaking and not speaking).

A number of 5 m^3 is established as the minimum for each check, the masks used are made of paper as well as the caps.

It can be seen (Table 1) that the wearing of the mask and of the cap have no influence on the emission of the microorganisms. During the experiments, while the person was speaking, he avoided spluttering.

Experiments were made with various persons, wearing clothes of different types: street clothes, bathing dress, hospital clothes made of cotton (pajamas, smocks, boots) of various types (identical sterilized and not sterilized clothes).

The subjects neither carried a mask nor the cap, considering the previously obtained results.

TABLE I. NUMBER OF MICROORGANISMS EMITTED BY THE HEAD
PER MINUTE

Tests carried out under the same conditions
without the presence of the head below the < 10 pnc/mn
biocollector

	Without first person	17
	Mask second person	9
Without speaking	With mask	4
	With mask and cap	4
	Washed face-with cap	4
	Washed face + mask + cap	4
	Without first person	25
While speaking	Masked second person	15
	With mask	4

The number of cubic meters measured is 10 m^3 at a minimum for each test.

In spite of the dispersion of the results caused by tests carried out with different persons, it can be seen that the nature, and even the absence of clothes, do not influence the aerobiocontamination in a significant way which is emitted by a person. (Table II).

Each column of Table II corresponds to a test carried out by the same person on a different date.

The Table III gives the average values of particles which were the origin of a colony per cubic meter in an aerobiologically clean room (with unidirectional flux) without humans, downstream of the head, downstream of a person and in a "sterile" operational

TABLE II. NUMBER OF MICROORGANISMS EMITTED BY THE
HUMAN BODY PER MINUTE

A dressed man in city clothes	620	1300	500	400	220
A bare-chested man with street trousers	400				
A man in bathing costume and street shoes	570	1000	690	370	500
A man in sterile pajamas and sterile boots		950		810	250
A man in sterile pajamas + sterile smock + sterile boots				1700	350
A man dressed with two pajamas and sterile boots					470

TABLE III. NUMBER OF PARTICLES FORMING THE ORIGIN OF A
COLONY PER CUBIC METER

Aerobiologically clean room (unidirectional flux)				Conventional sterile room with- out humans
Without humans	Downstream of the head	Downstream of a person		
-	-	-		
		about		
< 10 pnc/m ³	< 15 pnc/m ³	100 pnc/m ³	> 100 pnc/m ³	

area (Greene and Associates).

It can be seen that the concentration of microorganisms in the most unfavorable case, that is, downstream of a person, is smaller than the one obtained under conventional sterile conditions.

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In conclusion, the results show that the number of microorganisms emitted by the head of a person placed in a biologically clean enclosure does not depend on whether or not he is wearing the mask and the boots, and represents approximately a few percent of the microorganism emissions of a person.

The global emission of microorganisms by this person placed in a biologically clean enclosure, does not depend on the type or condition of the clothes worn.

The degree of aerobiocontamination of an enclosure with unidirectional flow is considerably smaller, even in the most unfavorable case, compared with the degree of aerobiocontamination of a classical "sterile" operating area.

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DISCUSSION

J. Creyssel. Your first conclusions surprised me. You said that the masks do not modify the aerobiocontamination, but according to your slides, I would have believed that there was a large difference.

J. Francillon. I have only been familiar with these laminar fluxes for a short time. The International Surgical Society devoted a volume to vertical and horizontal laminal fluxes. There is an absolute preference for the former.

It is possible to inoculate the tissue of surgical smocks.

Is there any importance in wearing a sterile hat underneath the smock?

Do you have an idea of the substances which will not be pierced in 20 minutes?

J. D. Joubert. In the case of a classical operating room, the number of microorganisms suspended in the air is a few hundreds /m³. In the case of a laminar flux room without personnel, the number of microorganisms is on the order of a few units/m³. Therefore, in order to determine the degree of aerobiocontamination of a laminar flux room, it is necessary to measure several m³ in order to have good accuracy in the results obtained, which represents a technical difficulty.

One of the disadvantages of vertical laminar flux rooms is that during the operation the head of the surgeon can be above the operating table. Our tests determine the degree of aerobiocontamination at the level of the operating table, when the heads of four persons are above the table. Considering the

experimental errors, it can be established that the contribution of the head from the point of view of aerobiocontamination is small, and one cannot observe a significant difference between persons wearing and not wearing masks or caps.

In order to differentiate in a few words a classical room from a laminar flux room, I would say that in a classical room the bacteria "circulate" because of the air conditioning. Our experiment shows that the degree of aerobiocontamination of operating areas called aseptic, in general, was higher than for the exterior air, which in good French, means that the operating rooms called clean are more dirty from a point of view of aerobiocontamination than the outside air in general. In the case of laminar flux rooms, the bacteria are entrained by the air flux, which is under the influence of a piston which continuously cleans the room. The number of bacteria in suspension in the air is 100 times smaller than that in the ambient air on the average.

The results which we have demonstrated in this note as well as the development of new types of illumination, which do not counteract the flux, at the present time lead us to assume that the vertical laminar flux technique is the best.

R. Guillet! What is the microbe emission of the patient in the chamber?

J. D. Joubert. The classical tissues utilized in operating areas were not at all researched with the purpose of preventing bacteria from passing through. We have shown that at the end of a few minutes, the bacteria emitted by the body passes through the tissue and soils the exterior surface of the clothes of surgeons.

The only tissue which constitutes an effective filter is waterproof tissue, but as far as we know, it is not comfortable for the surgeon.

All our tests were carried out for germs in natural suspension in the air. This was done for two reasons:

- from the point of view of the physics, the "dimensions" of microorganisms in the air differ from those of artificially generated microorganisms.
- experience shows that the flora emitted by humans is "identical" to the natural bacterial flora in the air. This is for the case where the human does not "splutter". In this case, the flora emitted is both quantitatively and qualitatively vastly different.

G. Arnulf. Did you make a comparison with ultraviolet units which, in general it has been said, result in practically complete sterilization, and which is easier and cheaper to install?

J. D. Joubert. All of the experiments which we carried out were done by simulating operations.

The effectiveness of ultraviolet rays is, at the present time, in the center of controversy. Therefore, we used as a basis these studies made over the last forty years. We experimentally were able to reverify the results of our predecessors relative to the effect of ultraviolet rays on artificial bacterial aerosols. That is to say, the ultraviolet rays are effective against artificially-generated bacterial aerosols. On the other hand, we experimentally verified that the same ultraviolet tubes operating under the same conditions had almost no effect against microorganisms which were naturally suspended in the air.

L. Fischer. Is there a difference in the degree of comfort for the surgeon depending on the type of laminar flux, in particular, as regards temperature?

J. D. Joubert. Contrary to what one might think, the laminar flux is very agreeable. The human is much more sensitive to the velocity difference than the absolute value of velocity. In a laminar flux room, the velocity is essentially uniform. However, it should be stated that, because of a large number of hourly renewals, the air to a great extent is recycled and must be conditioned in an absolute manner.

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